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(54) **METHOD FOR OPERATING A COMMUNICATION MODULE, AND COMMUNICATION MODULE**

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CPC *H04L 63/0227* (2013.01)

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USPC 726/13
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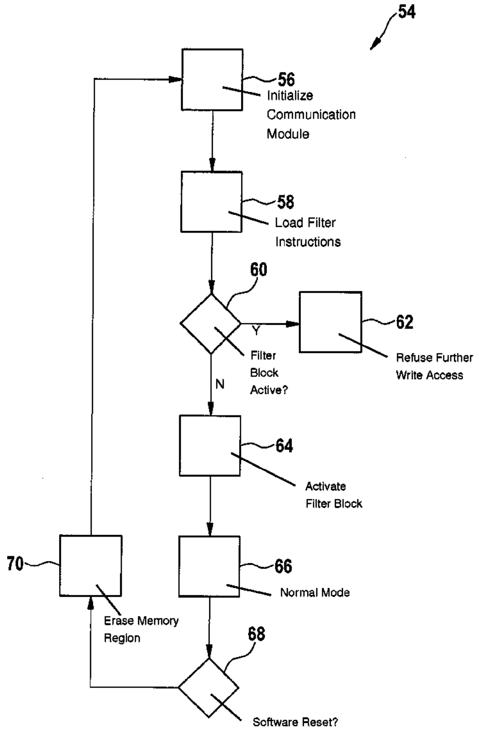
(57) **ABSTRACT**

A method for operating a communication module of a network element of a communication network as well as the communication module itself are described. The communication module is embodied for the transmission of data. The network element has a communication module and an interface for communication with further network elements of the communication network. The communication module is embodied in such a way that the transmission, via the interface, of data for transmission is inhibited or authorized on the basis of a filter instruction.

29 Claims, 2 Drawing Sheets



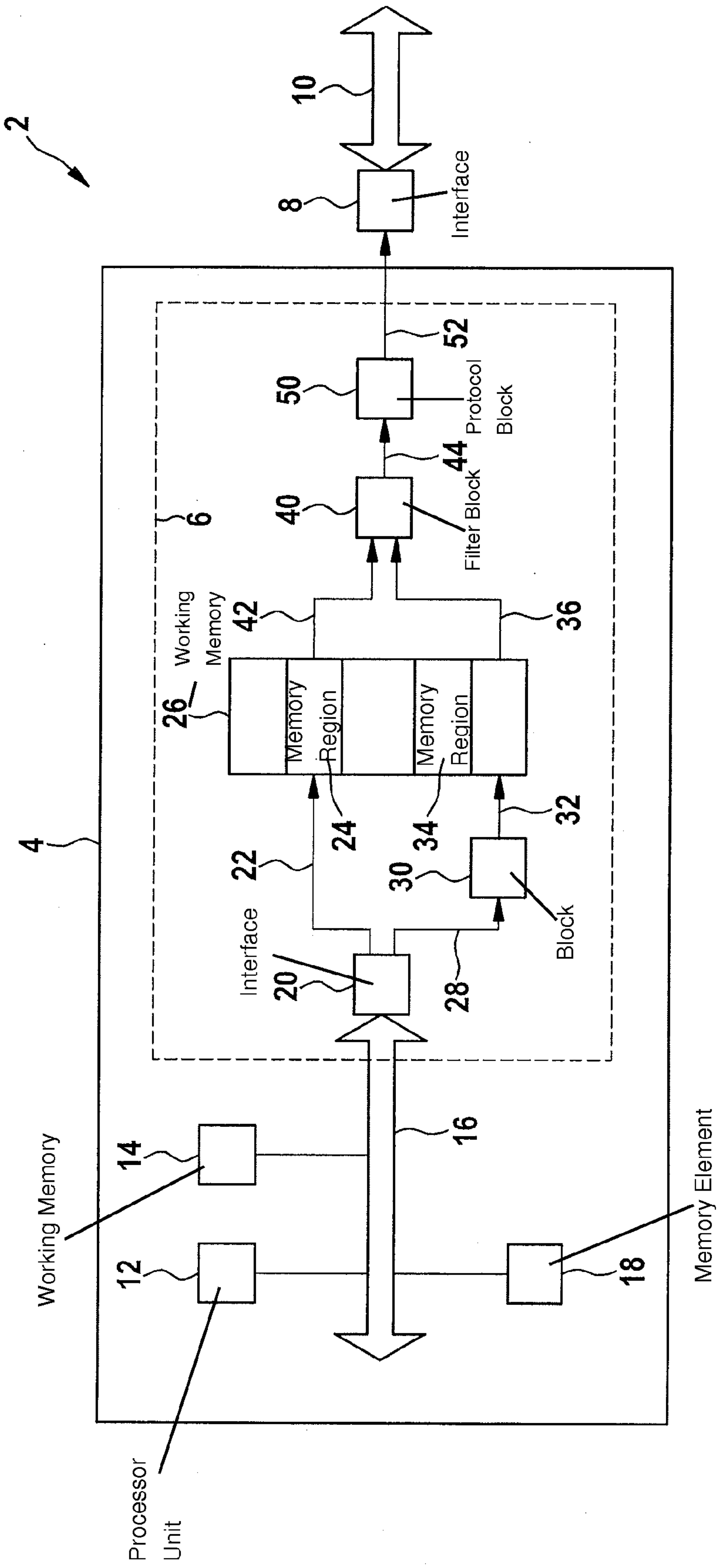

2
10
8
Interface
4
6
52
50
Protocol Block
44
40
Filter Block
42
36
Working Memory
26
Memory Region
24
Memory Region
34
22
32
30
Block
Interface
20
28
16
14
Working Memory
12
18
Memory Element
Processor Unit

Fig. 1

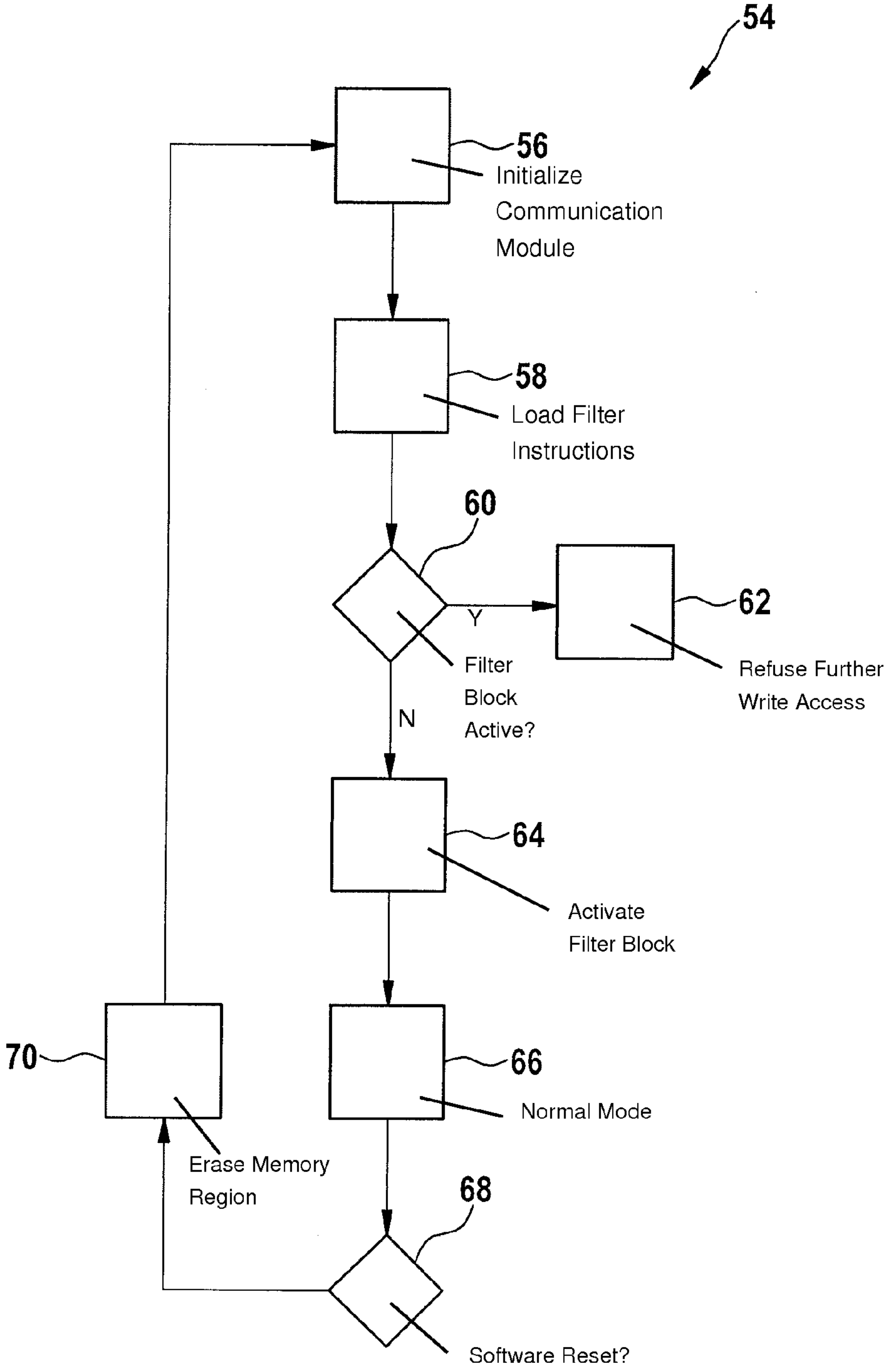

54
56
Initialize
Communication
Module
58
Load Filter
Instructions
60
Y
62
Filter
Block
Active?
Refuse Further
Write Access
N
64
Activate
Filter Block
70
66
Normal Mode
Erase Memory
Region
68
Software Reset?

Fig. 2

METHOD FOR OPERATING A COMMUNICATION MODULE, AND COMMUNICATION MODULE

FIELD OF THE INVENTION

The present invention relates to a method for operating a communication module, and to a communication module.

BACKGROUND INFORMATION

A plurality of features, in the form of units connected to bus systems and/or software-based solutions, are known for enhancing the availability and security of bus systems in modern motor vehicles. The goal of these solutions is on the one hand to ensure communication between the network elements, and on the other hand to maintain the functionality of the network elements.

German Published Patent Appln. No. 10 2011 077 409 discloses a connection node for a communication network, which node is provided for connecting a network element and for connecting to the communication network. The connection node is embodied to read and/or modify and/or inhibit data exchanged between the communication network and the network element. The connection node is embodied, in particular, physically and/or electrically independently of the communication network and of the network element.

SUMMARY

The problem on which the invention is based is solved by a method for operating a communication module, and by a communication module.

According to the present invention the transmission, via an interface of a network element, of data for transmission is inhibited or authorized on the basis of a filter instruction. This filtering of outgoing data advantageously makes it possible for a malfunction on the part of the network element not to cause the further network elements of the communication network to be substantially impaired by said malfunction.

A malfunction of the network element can be triggered, for example, by a hardware fault or software fault, or by another unintended faulty system function. In particular, the malfunction of a network element lies outside a previously defined specification.

Malicious programs in the form of application software can be triggers for a malfunction. For example, a malfunction can be triggered by a so-called “Trojan” software program of a third party, the Trojan in the form of an application software program initially not being categorized as potentially malicious. At run time as well, components of the application software can be manipulated using corresponding techniques such as, for example, buffer overflow, and can result in a malfunction of the network element. This malfunction can result in the possibility of an unexpected communication pattern being triggered.

The approach according to the present invention contributes to reducing or entirely preventing the effects of the malfunction of a network element on the further network elements of the communication network. The network element thus substantially monitors itself via the communication module. In particular, a network element whose application software has been manipulated cannot be used to carry out attacks via the communication network on further network elements. The security and reliability of the communication network are thereby greatly enhanced.

In a further embodiment, in a startup mode of the network element and/or of the communication module the filter instruction is loaded from a nonvolatile memory into a memory region of a working memory of the communication module. The communication module is configured in such a way that in a normal mode following the startup mode, write access to the memory region in which the filter instruction is stored is inhibited. This advantageously ensures that the self-monitoring cannot be manipulated by malicious application software, since in the startup mode, in contrast to the normal mode, no application software that is associated with a layer of higher order than the system mode of the network element is yet being executed.

In a further advantageous embodiment, prior to the startup mode of the communication module and/or in the startup mode of the network element, but in particular before loading of the filter instruction into the memory region of the working memory of the communication module, that memory region is erased. This explicit erasure of the memory region for the filter instruction yields an additional safeguard with regard to manipulation attempts. Depending on the embodiment, for example, the working memory could be configured in such a way that, for example, it survives a software reset, so that the data stored in that memory region are retained. The explicit erasure results in increased security with regard to any manipulation attempts.

In an embodiment of the invention, the filter instruction encompasses one or more filter parameters. The filter parameter or one of the filter parameters is, for example, one or more target addresses to be detected and/or target address regions to be detected and/or a bit mask and/or a message identifier to be detected. The filter parameter is applied to the additional information accompanying the data for transmission. This advantageously creates the possibility of defining a communication pattern for the network element. In particular, the application software that is running on the network element can advantageously be limited in terms of its transmitting activity by a fixed communication pattern for outgoing data. This defined communication pattern results from one or more filter instructions, and is defined substantially independently of the specification of the application software and stored independently of the application software for access for the application via the communication module.

In an advantageous refinement, a data unit for transmission is detected by the communication module by way of a filter instruction, the filter instruction stipulating, by way of a further filter parameter, whether transmission of the detected data unit is inhibited or authorized. The advantageous result of this is that both positive and negative lists for data units detected on the basis of other filter parameters can be defined. Further degrees of freedom in defining filter instructions result therefrom.

Features important for the invention may also be found in the drawings below; even in the absence of further explicit instruction in that regard, the features can be important for the invention both in isolation and in different combinations.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic block diagram of a network element.

FIG. **2** is a schematic flow chart of a method for operating a communication module.

DETAILED DESCRIPTION

FIG. **1** shows a schematic block diagram **2** of a network element **4**. Network element **4** encompasses a communication module **6**. Communication module **6** of network element **4** also has associated with it an interface **8** through which communication is possible respectively with a communication network **10** and with a further network element of communication network **10**. Communication module **6** of network element **4** is embodied in particular to transmit data to communication network **10** and also to receive it. FIG. **1** does not illustrate any elements that relate to the reception of data from communication network **10**. Communication network **10** can, of course, also be embodied therefor. Communication network **10** encompasses further network elements.

The embodiment of network element **4** depicted in FIG. **1** is of course only an exemplifying embodiment. Alternatives to the embodiment depicted will be respectively explained below. In particular, the association of individual elements of network element **4** with communication module **6** can be embodied differently.

Network element **4** can be embodied in particular as a microcontroller, or can encompass a microcontroller, that encompasses a processor unit **12** and a working memory **14**. The microcontroller furthermore encompasses a data bus **16** by way of which processor **12** can access working memory **14**.

Network element **4** further encompasses a memory element **18** in which one or more filter instructions are stored. Memory element **18** is protected (in a manner not shown) from arbitrary overwriting by, for example, application software. Memory element **18** is also referred to as a “nonvolatile” memory. For example, memory element **18** can be protected, by a hardware security module (HSM) (not depicted), from a write access proceeding from data bus **16**.

An interface **20** creates the connection between data bus **16** and communication module **6**. In a normal mode of network element **4** and/or of communication module **6**, processor **12** loads programs to be executed, or parts thereof, into working memory **14** in order to generate data that are provided for transmission to one or more further network elements of communication network **10**. In normal mode the data for transmission, after storage in working memory **14**, are conveyed to interface **20** which, as indicated by an arrow **22**, deposits the data for transmission into a memory region **24** of a working memory **26** that is associated with communication module **6**.

In a startup mode of communication module **6** and/or of network element **4**, which is followed by the normal mode, at least one filter instruction is conveyed out of memory element **18** via interface **20** (indicated by arrow **28**) to a block **30**. Block **30** is embodied in such a way that in the startup mode of network element **4** or in the startup mode of communication module **6**, it conveys or loads the at least one filter instruction (indicated by arrow **32**) into a memory region **34** only once.

Immediately after the one-time writing of the at least one filter instruction out of memory element **18** into memory region **34** by block **30** in the startup mode, block **30** prevents write access to memory region **34** in particular in the normal mode that follows the startup mode.

Write access to memory region **34** in which the at least one filter instruction is stored is consequently inhibited. All write access queries that arrive at block **30** (indicated by arrow **28**) are therefore blocked.

In an alternative embodiment, memory element **18** can be not connected to data bus **16** but instead associated with communication module **6**, and associated, for example, with block **30** (indicated by arrow **28**).

Before the startup mode and/or in the startup mode, but in particular before the at least one filter instruction is loaded into memory region **34** of working memory **26** of communication module **6**, memory region **34** is erased by block **30**.

Block **30** can be embodied as either hardware or software. Protection against further overwriting of memory region **34** of working memory **26** can be realized, for example, by a hardware-implemented function of setting a bit protected from further accesses, such that block **30** authorizes or inhibits write access as a function of the bit once it has been set.

Alternatively, the aforementioned function of block **30** can also be embodied as operating software for communication module **6**, access being inhibited during the run time of the operating software of communication module **6**, and access to the program code, which is stored in a memory and represents the operating software, being inhibited.

The startup mode of network element **4** is characterized in that after a hardware reset or software reset, or after an activation of network element **4**, processor **12** is not yet executing any application software. In the normal mode that follows the startup mode, on the other hand, application software is executed by processor unit **12**. Application software is notable for the fact that it does not make available the basic operating functions of network element **4** and/or of communication module **6**, but instead relates to higher-order device functions. In the startup mode, only operating software, and not application software, is executed; in the startup mode the operating software categorically cannot be manipulated by application software, since no application software is executed in the startup mode.

The at least one filter instruction stored in memory region **34** is conveyed (indicated by an arrow **36**) to a filter block **40**. In filter block **40**, the data for transmission are conveyed (indicated by an arrow **42**) out of memory region **24** of working memory **26**. Filter block **40** of communication module **6** is embodied in such a way that transmission of the data for transmission out of memory region **24** of working memory **26** via interface **8** is inhibited or authorized on the basis of the at least one filter instruction from memory region **34** of working memory **26**. Memory regions **24** and **34** can of course be disposed in different working memories.

A filter instruction can encompass one or more filter parameters. A filter parameter can be, for example, one or more target addresses to be detected and/or target address regions to be detected and/or a bit mask and/or a message identifier to be detected.

Block **40** ensures that one or more filter parameters are applied to additional information accompanying a data unit for transmission. This additional information can be, for example, a CAN identity and/or an Ethernet address and/or a Flexray identity and/or an IP (internet protocol) address. In the case of a bit mask, the additional information is AND-combined with the bit mask. Multiple filter parameters can of course apply a filter instruction successively in time to the additional information item.

As a result of the application of at least one filter parameter to an additional information item, block **40** detects a specific data unit for transmission. This detected data unit for transmission is then inhibited or authorized for transmission on the basis of a further filter parameter, this further filter parameter stipulating either inhibition of the detected data unit or authorization for transmission of the detected data unit. If the result of applying a filter instruction to a data unit for transmission is that transmission is authorized, filter block **40** then conveys (indicated by an arrow **44**) the data unit for transmission to a protocol block **50**. Protocol block **50** provides (indicated by an arrow **52**) for conveying the data for transmission to interface **8**.

FIG. **2** shows a schematically depicted flow chart **54**. According to a block **56**, communication module **6** is initialized or started; this corresponds to the startup mode.

According to a block **58**, the filter instructions are loaded into memory region **34**. Block **58** is associated with the startup mode. In the startup mode, the filter instructions are read out of memory element **18** and loaded via block **30** into memory region **34**. In one embodiment, the procedure according to block **56** can be implemented in hardware, so that block **30** loads the filter instructions out of memory element **18**, by way of a direct access via data bus **16**, into memory region **34** of working memory **26** of communication module **6**. In another embodiment, this loading of the filter instructions can also be executed as software, according to block **30** in communication module **6**. After loading of the filter instructions out of memory element **18**, block **30** inhibits any further write access to memory region **34** of working memory **26**.

According to query block **60**, a query is made during the startup mode as to whether filter block **40** is already active. If filter block **40** is already active, then according to block **30** another write access to memory region **34** is refused, and the filter instructions already loaded in memory region **34** are retained. This function of refusing a further write access corresponds to a block **62** as shown.

If filter block **40** is not yet active, however, then according to a block **64** activation of filter block **40** occurs, the latter block carrying out the functions described with reference to FIG. **1**. After successful activation of filter block **40** according to block **64**, according to a block **66** operation transitions into the normal mode, so that filter block **40** blocks the data for transmission in accordance with the filter instruction, or releases them for transmission.

If a software reset query then occurs according to a block **68**, block **30** then ensures, according to block **70** shown in FIG. **2**, that memory region **34** of working memory **26** of communication module **6** is erased before a restart of communication module **6**.

Alternatively or in addition to block **70**, a further block (not shown) can be disposed according to block **70** between block **56** and block **58** in order to explicitly erase memory region **34** of working memory **26**, for example, after a startup of communication module **6** triggered by a hardware reset or software reset. After a hardware reset, the process sequence shown in FIG. **2** begins at block **56**. A hardware reset is associated with an at least brief interruption in current transmission, which results categorically in loss of the content of a volatile working memory. In the case of a software reset, conversely, a memory content of a volatile working memory can (depending on its embodiment) be retained.

An additional filter parameter of a filter instruction can stipulate that when block **40** has detected a data unit to be inhibited, communication module **6** or network element **4** carries out a further method step. This further method step can be, for example, a diagnostic function, in which context block **40** writes the detected inhibited data unit into a memory (not shown). Another further method step in this case can relate, for example, to a notification of further network elements, said notification preferably being implemented by communication module **6**.

What is claimed is:

1. A method for operating a communication module of a network element of a communication network, the network element being embodied for a transmission of data, the method comprising:

associating an interface for communication with further network elements of the communication network with the communication module, wherein the communication module is configured so that the transmission, via the interface, of data for transmission to one of the further network elements is one of inhibited and authorized based on a filter instruction; and

in a startup mode of at least one of the network element and the communication module, loading the filter instruction from a nonvolatile memory into a memory region of a working memory of the communication module, wherein the communication module is configured so that in a normal mode of at least one of the network element and the communication module following the startup mode, write access to the memory region in which the filter instruction is stored is inhibited.

2. The method as recited in claim **1**, further comprising: prior to the startup mode, erasing the memory region.

3. The method as recited in claim **2**, wherein the memory region is erased before loading of the filter instruction into the memory region of the working memory of the communication module.

4. The method as recited in claim **1**, wherein: the filter instruction encompasses at least one filter parameter, the at least one filter parameter including at least one of:

at least one target address to be detected,

at least one target address region to be detected, and

at least one of a bit mask and a message identifier to be detected, and the at least one filter parameter is applied to additional information accompanying the data unit for transmission.

5. The method as recited in claim **4**, wherein the additional information includes at least one of a CAN identity, a Flexray identity, an Ethernet address, and an IP address.

6. The method as recited in claim **4**, further comprising: detecting a data unit for transmission by the communication module by the filter instruction, wherein the filter instruction stipulates, by a further filter parameter, whether transmission of the detected data unit is one of inhibited and authorized.

7. The method as recited in claim **1**, wherein the nonvolatile memory for storing the filter instruction is configured so that overwriting by application software of the network element is not possible.

8. A non-transitory computer readable medium having a computer program, which is executable on a network element, comprising:

a program code arrangement having program code for operating a communication module of a network element of a communication network, the network element being embodied for a transmission of data, by performing the following comprising:

associating an interface, via the network element, for communication with further network elements of the communication network with the communication module, wherein the communication module is configured so that the transmission, via the interface, of data for transmission to one of the further network elements is one of inhibited and authorized based on a filter instruction; and

in a startup mode of at least one of the network element and the communication module, loading the filter instruction from a nonvolatile memory into a memory region of a working memory of the communication module, wherein the communication module is configured so that in a normal mode of at least one of the network element and the communication module following the startup mode, write access to the memory region in which the filter instruction is stored is inhibited.

9. The non-transitory computer readable medium as recited in claim **8**, wherein the network element is associated with the communication module.

10. The non-transitory computer readable medium as recited in claim **8**, wherein prior to the startup mode, the memory region is erased.

11. The non-transitory computer readable medium as recited in claim **10**, wherein the memory region is erased before loading of the filter instruction into the memory region of the working memory of the communication module.

12. The non-transitory computer readable medium as recited in claim **8**, wherein: the filter instruction encompasses at least one filter parameter, the at least one filter parameter including at least one of:

at least one target address to be detected,

at least one target address region to be detected, and

at least one of a bit mask and a message identifier to be detected, and the at least one filter parameter is applied to additional information accompanying the data unit for transmission.

13. The non-transitory computer readable medium as recited in claim **12**, wherein the additional information includes at least one of a CAN identity, a Flexray identity, an Ethernet address, and an IP address.

14. The non-transitory computer readable medium as recited in claim **12**, wherein a data unit for transmission by the communication module is detected by the filter instruction, wherein the filter instruction stipulates, by a further filter parameter, whether transmission of the detected data unit is one of inhibited and authorized.

15. The non-transitory computer readable medium as recited in claim **8**, wherein the nonvolatile memory for storing the filter instruction is configured so that overwriting by application software of the network element is not possible.

16. A communication device for a network element of a communication network, comprising:

a communication hardware component configured to transmit data from the network element, wherein an interface for communication with further network elements of the communication network is associated with the communication hardware component, and wherein the communication hardware component is configured so embodied in such a way that the transmission, via the interface, of data for transmission to one of the further network elements is one of inhibited and authorized based on a filter instruction;

wherein in a startup mode of at least one of the network element and the communication hardware component the filter instruction is loaded from a nonvolatile memory into a memory region of a working memory of the communication hardware component, and wherein the communication hardware component is configured so that in a normal mode following the startup mode, write access to the memory region in which the filter instruction is stored is inhibited.

17. The communication device as recited in claim **16**, wherein, prior to the startup mode, the memory region is erased.

18. The communication device as recited in claim **17**, wherein the memory region is erased before loading of the filter instruction into the memory region of the working memory of the communication hardware component.

19. The communication device as recited in claim **16**, wherein: the filter instruction encompasses at least one filter parameter, the at least one filter parameter including at least one of:

at least one target address to be detected,

at least one target address region to be detected, and

at least one of a bit mask and a message identifier to be detected, and the at least one filter parameter is applied to additional information accompanying the data unit for transmission.

20. The communication device as recited in claim **19**, wherein the additional information includes at least one of a CAN identity, a Flexray identity, an Ethernet address, and an IP address.

21. The communication device as recited in claim **19**, wherein a data unit for transmission by the communication hardware component is detected by the filter instruction, wherein the filter instruction stipulates, by a further filter parameter, whether transmission of the detected data unit is one of inhibited and authorized.

22. The communication device as recited in claim **16**, wherein the nonvolatile memory for storing the filter instruction is configured so that overwriting by application software of the network element is not possible.

23. A network device element, comprising:

a communication hardware device for a network element of a communication network, the communication hardware device configured to transmit data from the network device element, wherein an interface for communication with further network elements of the communication network is associated with the communication hardware device;

wherein the communication hardware device is configured so that the transmission, via the interface, of data for transmission to one of the further network elements is one of inhibited and authorized based on a filter instruction,

wherein in a startup mode of at least one of the network device element and the communication hardware device the filter instruction is loaded from a nonvolatile memory into a memory region of a working memory of the communication hardware device, and wherein the communication hardware device is configured so that in a normal mode following the startup mode, write access to the memory region in which the filter instruction is stored is inhibited.

24. The network device element as recited in claim **23**, wherein prior to the startup mode, the memory region is erased.

25. The network device element as recited in claim **24**, wherein the memory region is erased before loading of the filter instruction into the memory region of the working memory of the communication hardware device.

26. The network device element as recited in claim **23**, wherein: the filter instruction encompasses at least one filter parameter, the at least one filter parameter including at least one of:

at least one target address to be detected,

at least one target address region to be detected, and at least one of a bit mask and a message identifier to be detected, and the at least one filter parameter is applied to additional information accompanying the data unit for transmission.

27. The network device element as recited in claim **26**, wherein the additional information includes at least one of a CAN identity, a Flexray identity, an Ethernet address, and an IP address.

28. The network device element as recited in claim **26**, wherein a data unit for transmission by the communication hardware device is detected by the filter instruction, wherein the filter instruction stipulates, by a further filter parameter, whether transmission of the detected data unit is one of inhibited and authorized.

29. The network device element as recited in claim **23**, wherein the nonvolatile memory for storing the filter instruction is configured so that overwriting by application software of the network element is not possible.

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